# Nitrogen and Phosphorus Fertilizer Requirements for Young, Bearing Microsprinkler-Irrigated Citrus, 2004 Report

***Thomas L. Thompson and Scott A. White***


## *Abstract*

*Higher nutrient and water use efficiency are possible with microsprinkler-irrigated citrus compared to flood-irrigated citrus. Therefore, new N and P fertilizer recommendations are needed for microsprinkler-irrigated citrus. The objectives of these experiments were to i) determine the effects of N applications on tree growth, fruit yield, fruit and juice quality, and N and P removal in fruit for microsprinkler-irrigated navel oranges; ii) determine the effects of P applications on tree growth, fruit yield, fruit and juice quality, and N and P removal in fruit, and iii) develop Best Management Practices for N and P fertigation of microsprinkler-irrigated citrus. Field experiments were conducted at the University of Arizona Citrus Agricultural Center in separate blocks of 'Newhall' and 'Fukumoto' navel oranges, both on 'Carrizo' rootstock. In each block, ten treatments, consisting of all possible combinations of 5 N rates (0, 0.2, 0.4, 0.6, and 0.8 lb N/tree/yr) and 2 P rates (0, 0.2 lb P/tree/year) were applied to five replicate trees per treatment. During the first year of this experiment, there were no effects of the treatments on fruit quality. In both varieties, N rates of 0.6 lb N/tree/yr resulted in leaf N above the critical concentration of 2.5%. The yield of both varieties was maximized at about 0.4 lb N/tree/yr, and in neither variety was there a significant response to P.*


## Introduction

Nitrogen is the nutrient most likely to limit yield and quality of citrus, and is the nutrient used in greatest quantity for citrus production. Adequate supplies of N are necessary to optimize yield of young citrus trees. Optimal growth and yield requires optimal levels of N and irrigation, but an excess of either is nonproductive, costly, and may result in loss of N by leaching and/or runoff.

Escalating water costs and declining water availability are causing growers to adopt production practices which allow them to significantly improve water use efficiency and decrease labor costs. One such practice is the installation of under-tree microsprinklers in place of conventional surface flood irrigation. In addition to allowing precise control of irrigation water applications, microsprinkler systems offer the ability to use fertigation with fluid fertilizer materials throughout the 9-month growing season.

Existing guidelines for fertilization of Arizona citrus crops were developed for flood irrigation. Previous research that we have conducted has demonstrated that the N rates recommended for young, non-bearing flood-irrigated citrus can be substantially reduced for microsprinkler-irrigated citrus. The lower N requirement is directly related to the higher water- and nutrient-use efficiency of microsprinkler irrigation compared to flood irrigation. We hypothesize that optimum N rates for fruit-bearing microsprinkler-irrigated citrus will also be lower than for flood-irrigated citrus. Field experiments are needed to test this hypothesis.

Arizona citrus crops are normally not fertilized with P. However, because of the altered pattern of root distribution and water and nutrient extraction in microsprinkler-irrigated citrus, compared to conventional irrigation methods, and the capability for P fertigation, current P fertilizer practices should be re-examined. Therefore, research is needed to define appropriate rates of fluid P inputs for microsprinkler irrigated citrus in the desert Southwest.

Increasing water costs and environmental concerns create a need for more efficient management practices for citrus production. Microsprinkler irrigation and fertigation have the potential to significantly increase production efficiency. However, there is evidence that existing N and P fertilization guidelines need to be revised for microsprinkler production systems. There is a particular lack of good information on young fruit-bearing citrus. The objective of this project is to investigate the effects of two important management variables, N rate and P rate, on tree growth, nutrition, and fruit yield and quality. From these results we intend to develop recommended Best Management Practices for microsprinkler-irrigated citrus. Development of more up-to-date fertilizer recommendations will help Arizona citrus growers optimize fertilizer management practices.

Recommended N rates for young, fruit-bearing citrus are generally based upon leaf N analysis or N removal in harvested fruit. The generally recommended critical leaf N concentration is 2.4-2.6%; within this concentration range tree N status is considered "optimum". Current Arizona recommendations are to apply 1-2 lb N/tree/yr to young bearing citrus with optimum leaf N (Doerge et al., 1991). However, these recommendations were derived for flood-irrigated citrus. The International Fertilizer Association (2002) summarized N recommendations worldwide for 6-year-old (bearing) citrus. Recommended rates were generally from 0.6 - 1.0 lb N/tree/yr. In Texas, N rates for 6-8 year-old citrus are 1 - 1.25 lb/tree/yr (Sauls, 2002). Florida recommendations call for similar rates of N application and are based upon leaf N concentration.

None of the recommendations cited in the previous paragraphs were developed for microsprinkler-irrigated citrus. Only the Texas recommendations explicitly recognize the higher efficiency of microsprinklers by recommending a 20% reduction in N rate with microsprinklers (Sauls, 2002). Previous research at the University of Arizona has demonstrated that optimum N rates for newly-planted microsprinkler-irrigated citrus are significantly lower than rates previously considered optimum for flood-irrigated citrus (Weinert et al., 2002). This is probably because of the higher water- and nutrient-use efficiency that is possible with microsprinkler irrigation. It is reasonable, therefore, to hypothesize that optimum N rates for young, bearing microsprinkler-irrigated citrus will also be lower than for flood-irrigated citrus. Because of the growing importance of microsprinklers in Arizona citrus production, there is an urgent need to determine optimum N rates.

Observed responses to P fertilization by citrus include increased juice content, increased soluble solids/acids in juice, increased yields, and decreased rind thickness (Hilgeman et al., 1938; Embleton et al., 1956; Smith, 1963; C.A. Sanchez, Yuma, AZ, unpublished data). Citrus crops in central Arizona are customarily not fertilized with P, and previous research in this area has generally shown a lack of response to P fertilization (Hilgeman and Dunlap, 1972). However, recent research in western Arizona on sandy soils showed that mature citrus converted from border flood to microsprinkler irrigation responded to granular P fertilization (C.A. Sanchez, Yuma AZ, unpublished data).

The objectives of this project are to i) determine the effects of N applications of 0 - 1.0 lb/tree/yr on tree growth, fruit yield, fruit and juice quality, and N and P removal in fruit for microsprinkler-irrigated navel oranges; ii) determine the effects of P applications of 0 - 0.2 lb/tree/yr on tree growth, fruit yield, fruit and juice quality, and N and P removal in fruit, and iii) develop Best Management Practices for N and P fertigation of microsprinkler-irrigated citrus.

## Materials and Methods

Field studies have been conducted since March 1997 at the University of Arizona Citrus Agricultural Center in Waddell. The experiment is conducted on a Gilman loam soil, which has a pH of 8.0, $Ec_e$ of 0.7 dS/m, extractable K of 702 ppm, exchangeable sodium <1%, and $CaCO_3$ <1%. ‘Newhall’ navel orange trees on ‘Carrizo’ citrange rootstock and ‘Fukumoto’ on ‘Carrizo’ were planted in March 1997.

Fifty trees of each scion-rootstock combination are planted in separate blocks on 20' x 20' centers within the same field. Each plot contains one tree. The experiment consisted of all possible combinations of five N rates ( 0, 0.2, 0.4, 0.6, 0.8 lb N/tree/yr), and two P rates (0, 0.2 lb P/tree/yr), arranged in a randomized complete block design. Each of the 10 treatments was replicated five times. Each tree was equipped with two 300 degree Maxijet (Maxijet, Inc., Dundee, FL) microsprinklers (10.5 gph each) under the canopy. In-line Dosatron injectors were used to apply the

UN-32 and phosphoric acid (0-52-0) fertilizers. The N and P fertilizers were applied in nine fertigation events scheduled monthly from January to September. Irrigation was applied to maintain soil moisture above 70% available soil moisture, which is the optimum level for citrus trees (Fig. 1). A foliar application of Zn-EDTA was applied during Mar. 2004.

Leaf tissue was collected in August and analyzed for N and P to determine nutrient status of the trees as affected by N and P rates. Fruit was harvested on December 18, 2003. All fruit were processed through an automated fruit sizer, and eight fruit from each plot were collected, individually weighed, and juiced for determination of fruit and juice quality, including percent juice, peel thickness, brix, and titratable acidity. Selected fruit from each plot were oven-dried, ground, and analyzed for N and P concentration, to determine the mass of N and P removed in harvested fruit.

## Results and Discussion

This is the first year of this experiment, thus it was expected that results from the current treatments may not be evident yet.

*Leaf Tissue N* and P. Leaf N concentration increased with N rate in both varieties (Fig. 2), although the differences were statistically significant in the Fukumoto trees but not in the Newhall. The generally accepted “critical concentration” for N content in citrus leaves is 2.5% ( ). In both varieties, N rates of 0.6 lb N/tree/yr resulted in leaf N above the critical concentration Leaf P concentrations (Fig. 3) were not affected by P rate during this first year of P application..

*Fruit Yield and Quality*. The yield of both varieties was maximized at about 0.4 lb N/tree/yr (Fig. 4), and in neither variety was there a significant response to P applied. Fruit packout was determined, but there was no effect of the treatments on packout (data not shown). We also measured rind thickness, percent juice, soluble solids, and acidity (Tables 1 and 2). There were no effects of the treatments on any of these quality parameters.

Leaf N and yield were responsive to N rate. Other than these effects, there were no effects of the treatments on fruit quality. It should be remembered, however, that this is the first year of this experiment. Response of trees to the treatments may be more obvious during subsequent years.

## Literature Cited


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Figure 1 Soil water tension during 2003.

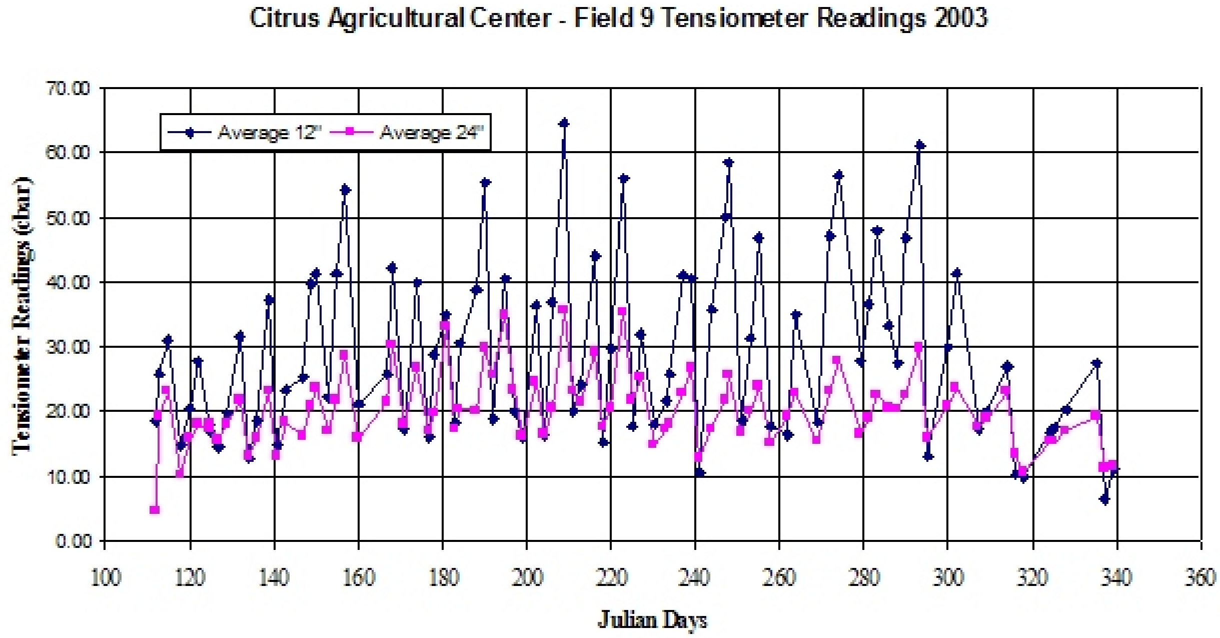


Figure 2 Leaf N, August 2003.

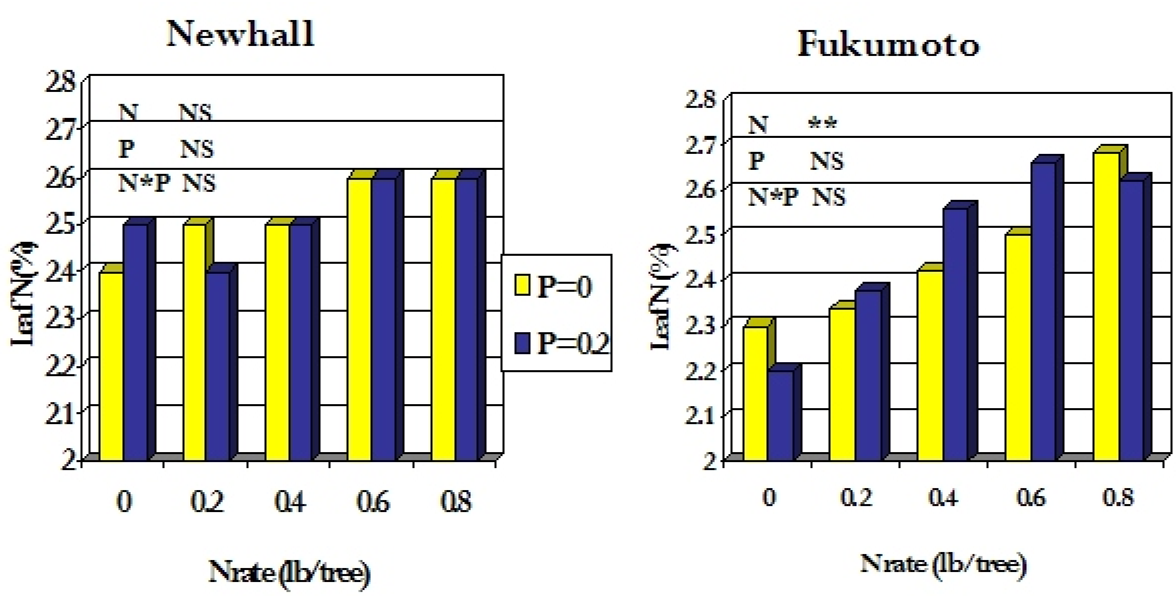

Figure 3 Leaf P, August 2003.

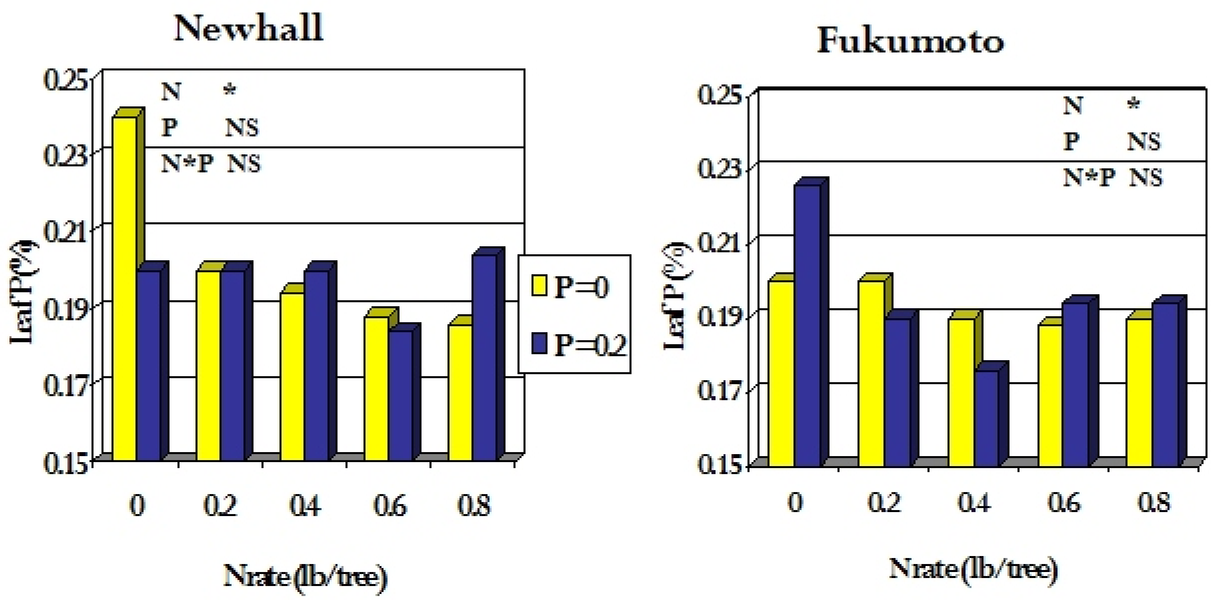


Figure 4 Yield, Dec. 18, 2003.

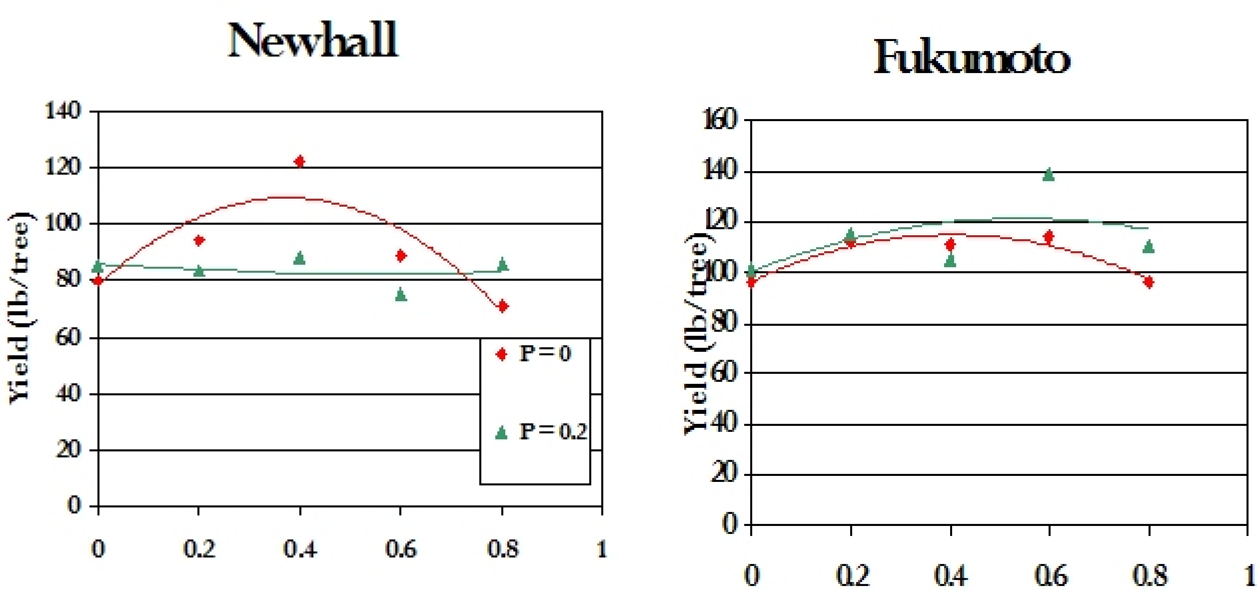

Table 1. ‘Newhall’ fruit quality data for the December 2003 harvest.

| N rate | P rate | Rind Thickness | Juice | Brix | TSS/TA |
|---|---|---|---|---|---|
| lb/tree/yr | lb/tree/yr | mm | % | % | |
| 0 | 0 | 7.0 | 32.4 | 11.1 | 26.6 |
| 0 | 0.2 | 6.8 | 35.8 | 12.3 | 25.5 |
| 0.2 | 0 | 7.1 | 35.1 | 12.1 | 25.1 |
| 0.2 | 0.2 | 7.4 | 30.8 | 10.8 | 27.6 |
| 0.4 | 0 | 7.1 | 37.4 | 10.9 | 27.3 |
| 0.4 | 0.2 | 6.6 | 38.6 | 11.4 | 23.1 |
| 0.6 | 0 | 7.7 | 37.1 | 11.8 | 27.8 |
| 0.6 | 0.2 | 7.2 | 36.6 | 11.4 | 24.5 |
| 0.8 | 0 | 6.7 | 35.9 | 11.9 | 29.7 |
| 0.8 | 0.2 | 7.0 | 38.4 | 12.0 | 25.6 |

Table 2. ‘Fukumoto’ fruit quality data for the December 2003 harvest.

| N rate | P rate | Rind Thickness | Juice | Brix | TSS/TA |
|---|---|---|---|---|---|
| lb/tree/yr | lb/tree/yr | mm | % | % | |
| 0 | 0 | 5.9 | 40.0 | 12.7 | 25.1 |
| 0 | 0.2 | 6.3 | 39.6 | 11.8 | 25.3 |
| 0.2 | 0 | 6.1 | 41.4 | 11.6 | 25.5 |
| 0.2 | 0.2 | 6.3 | 38.1 | 11.3 | 23.3 |
| 0.4 | 0 | 5.9 | 40.0 | 12.0 | 26.6 |
| 0.4 | 0.2 | 5.9 | 40.6 | 12.2 | 25.4 |
| 0.6 | 0 | 6.4 | 40.3 | 12.3 | 26.4 |
| 0.6 | 0.2 | 5.8 | 41.9 | 11.5 | 23.7 |
| 0.8 | 0 | 6.0 | 36.8 | 11.6 | 22.1 |
| 0.8 | 0.2 | 6.2 | 41.0 | 11.9 | 24.9 |